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Possible Health Hazards for Cardiac Pacemaker Wearers from Exposure to Electromagnetic Fields

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**POSSIBLE HEALTH HAZARDS FOR CARDIAC PACEMAKER
WEARERS FROM EXPOSURE TO ELECTROMAGNETIC FIELDS**

**Physical Hazards Group
Canadian Centre for Occupational Health and Safety**

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POSSIBLE HEALTH HAZARDS FOR CARDIAC PACEMAKER WEARERS FROM EXPOSURE TO ELECTROMAGNETIC FIELDS

This publication was prepared as a source of information for health and safety committees who may have to deal with the problem of possible health hazards to cardiac pacemaker wearers from exposure to electromagnetic fields.

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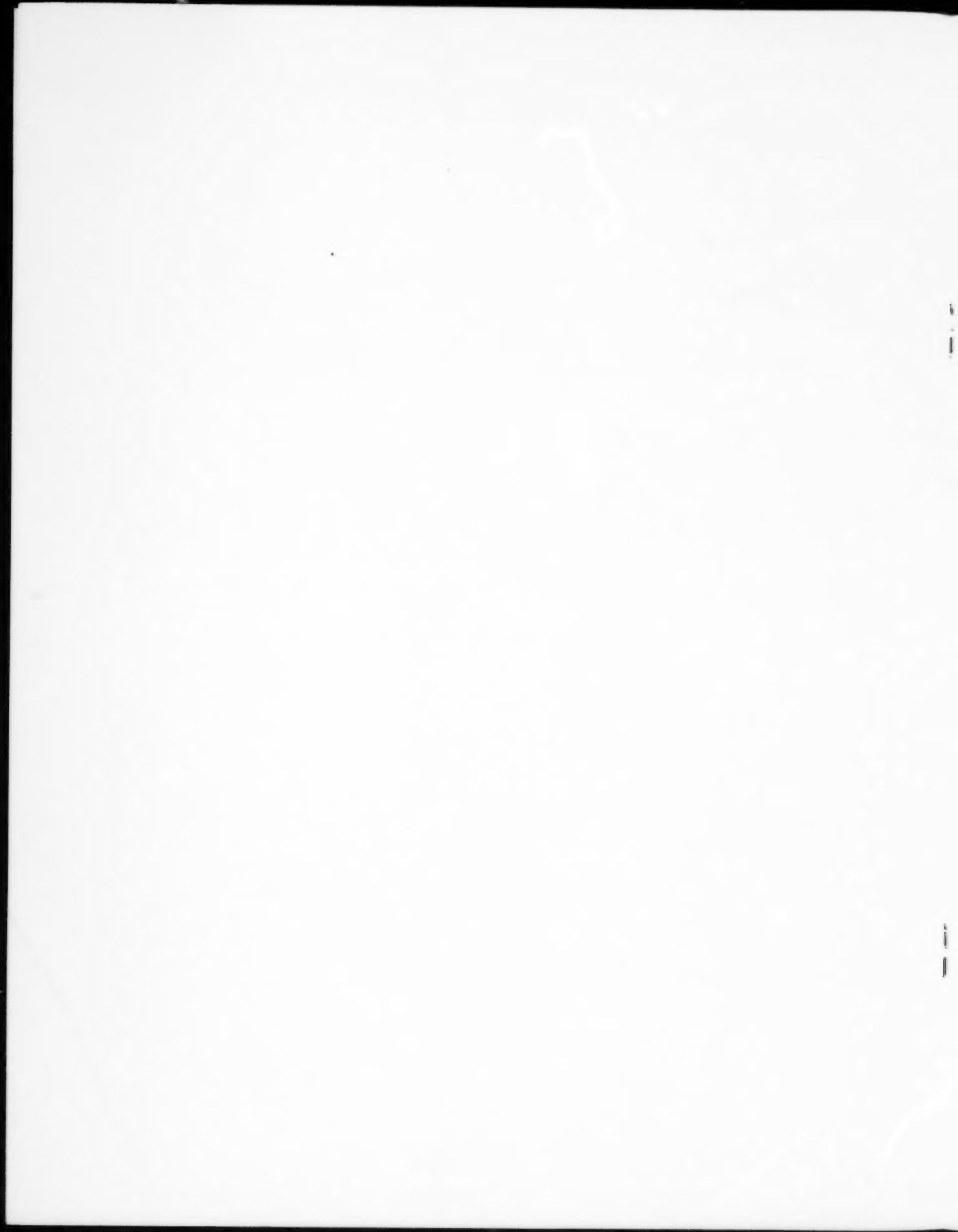
INTRODUCTION

The heart has its own natural pacemaker which provides electrical impulses. These impulses travel through the heart muscle, causing the heart to contract, or beat, circulating the blood through the body periodically. A healthy heart beats between 60 to 80 times per minute, depending on the level of physical or mental activity.

Artificial cardiac pacing may be required when there is a significant malfunction of the heart's bioelectrical system. Sometimes the heart's natural rhythm becomes irregular from heart disease, damage from a heart attack, or degeneration from the aging process. The heart's natural pacemaker may send out electrical impulses too slowly. The impulses might be blocked along the pathway through the heart, resulting in a condition called "heart block." In all these situations, the heartbeat is slow or unsteady. Slow heart rates lead to a decrease in the flow of blood pumped from the heart and can result in serious symptoms, including dizziness.

A cardiac pacemaker is an electronic device which produces electrical pulses to replace or override the natural pacemaker.

There are very few limitations placed on today's pacemaker patients. Pacemakers are well protected against common electromagnetic fields, such as those from household appliances. But intense electromagnetic fields, such as those found in some industrial settings, could affect the functioning of the pacemaker.



1. HOW CARDIAC PACEMAKERS WORK

A cardiac pacemaker consists of a pulse generator, lead wires and electrodes (see Figure 1 below). A typical pulse generator is buried under the skin of the chest. It produces low voltage (typically 2.5 volt), short duration (0.5 millisecond) pulses to the heart. The pulses may be applied to the heart at a rate of about 70 pulses per minute, but for some types of pacemakers, may vary in rate depending on the patient's needs. The lead wires, which also contain the electrodes, are typically inserted through a vein to the heart. They carry the electrical impulse from the pulse generator to the heart. Most current pacemakers use lithium metal-based batteries which last from 4 to 20 years, depending on the model and usage by the patient.

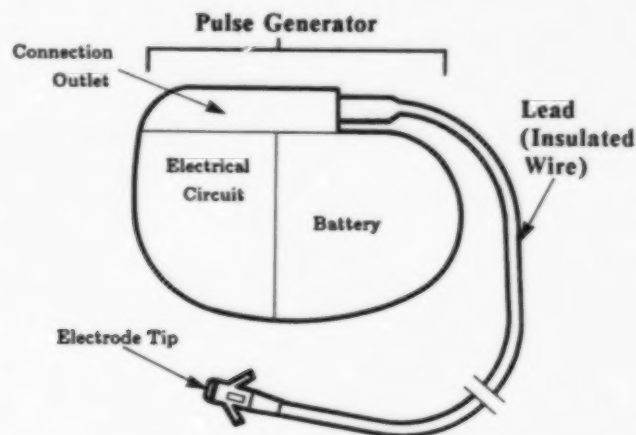


Figure 1 - A typical pacemaker consisting of a pulse generator and lead with electrodes. (Courtesy of Medtronic, Inc.)

2. TYPES OF CARDIAC PACEMAKERS

Most pacemakers today are of the demand standby type. They respond only if the patient's heart rate is too slow. In other words, as long as this type of pacemaker detects a natural heartbeat, it remains in a standby mode. It monitors the heart, beat by beat.

There are two types of permanent, implanted pacemakers--rate responsive and non-rate responsive.

Rate responsive pacemakers are used by patients who always have slow heart rates. This type of pacemaker can detect the body's need for increased cardiac output (due to exercise, for instance) and then increase the pacing rate accordingly.

Non-rate responsive pacemakers are typically used by patients who only occasionally have a slow heart rate. The pacemaker may be set at a fixed rate (60 beats per minute, for example) and hardly ever pace.

3. SUSCEPTIBILITY TO ELECTROMAGNETIC INTERFERENCE

Cardiac pacemakers may be susceptible to interference from electromagnetic fields, so they are designed to reject possible interference. The lead wires and electrodes can act as a receiving antenna for some types of electromagnetic fields. Although the pulse generator can be affected by these under certain circumstances, it is usually encapsulated in a metal casing which shields it from external fields.

4. SOME EFFECTS OF ELECTROMAGNETIC FIELDS ON PACEMAKER PERFORMANCE

Strong electromagnetic fields can cause a demand-type pacemaker to revert to an asynchronous mode; that is, the pacemaker will not detect the natural electrical impulses from the heart. The result could be pacing in competition with, instead of in coordination with, the normal heart impulses and beats. Competitive pacing may cause some minor disruptions in cardiac output. In a small number of cases, there is a risk of very fast and dangerous rhythms being produced. The patient should consult a physician to determine if this will matter.

If an interfering field (for example, a pulsed field) mimics a normal cardiac signal, the pacemaker may confuse this with a natural heartbeat and revert to the inhibited mode. The pacemaker behaves as if the heart were beating at a proper rate and pacing were not required. In this case, the pacemaker wearer may feel dizzy due to missed heartbeats.

In both cases, moving away from or turning off the source of the interfering electromagnetic field would cause the pacemaker to resume its normal operation.

These types of situations are usually not fatal, but could be hazardous to the pacemaker wearer or others if accidents result. For example, losing one's balance from dizziness as a result of pacemaker interference can be hazardous if the pacemaker wearer is on a ladder or operating machinery. There have been no reported cases of interfering electromagnetic fields causing a pacemaker to stop completely.

5. SOURCES OF ELECTROMAGNETIC INTERFERENCE

Pacemakers have been designed with circuitry to reject most interfering signals. But it is impossible to reject interference signals having the same characteristics as those from the heart, since to operate, the pacemaker must detect these signals.

Fields emitted from most electrical devices pose no threat to the pacemaker wearer. For instance, common household appliances (such as stereos, TVs, microwave ovens, vacuum cleaners, toasters) and office and shop equipment (including electric typewriters, video display terminals, woodworking tools, light metalworking tools) should be safe, provided that they are in good repair.

However, pacemakers have reportedly been affected by fields from a number of powerful industrial and environmental sources. These include the following:

- Pulsed fields from industrial or domestic electric arc welding equipment.
- Radiofrequency fields from high power transmitting towers and antennas.
- Radiofrequency fields from industrial dielectric and induction heaters.
- Shortwave or radiofrequency diathermy devices.
- Electric fields from high voltage powerlines.
- Strong magnetic fields, for example from nuclear magnetic resonance (NMR) imaging devices.
- Fields from some theft or weapon detectors.

6. HOW TO AVOID ELECTROMAGNETIC INTERFERENCE

Different makes of pacemakers have different sensitivities to interfering electromagnetic fields. There are so many potential sources of interference that it would be impractical to advise pacemaker wearers to avoid all of them, even if it were possible to identify each one in advance.

In any case, the pacemaker wearer should know, at least in general terms, about the possibility of electromagnetic interference. The risks are very low, but if dizziness or an increased heartbeat occurs, the pacemaker wearer should move away from the source. The farther away one moves from a source of electromagnetic interference, the lower the strength of the field and the less likely it is to interfere with the pacemaker. While it would be ideal to eliminate all sources of electromagnetic interference, it clearly is not possible to do so.

Pacemaker response to electromagnetic fields depends on many factors, including the frequency and waveshape characteristics of the field. To be on the safe side, a pacemaker wearer should try to minimize exposure to fields from the devices mentioned earlier. Some areas, for example libraries and weapon detection areas at some airports, contain warning signs for



pacemaker wearers. Although there have been only a few cases of pacemaker interference from these devices (see Sowton in the Further Reading list), they may detect the metal in the pulse generator, resulting in false alarms.

7. WHAT THE HEALTH AND SAFETY COMMITTEE SHOULD DO

For workplaces where known or potential sources of electromagnetic interference with cardiac pacemakers may be present, the health and safety committee should do the following:

- Identify possible sources of electromagnetic interference.
- If necessary, have measurements taken to determine various parameters of the field, for example field strength, frequency, waveshape.
- Attempt to reduce exposure to these fields, where practical.
- Consult the manufacturer of the pacemaker to obtain information on its susceptibility to electromagnetic fields from the sources identified.

8. SUMMARY

Cardiac pacemakers, used to provide electrical stimulation to the heart when the heart's natural rhythm is interrupted, can be susceptible to electromagnetic fields from powerful industrial and environmental sources. Such interference may cause the pacemaker wearer to feel dizzy or experience an accelerated heartbeat. While this is not fatal, the pacemaker wearer should try to move away from the source of the interfering field and avoid situations in which interference could arise. After experiencing any of these symptoms, the pacemaker wearer should contact a physician.

Potential sources of electromagnetic interference should be identified and characterized to determine if there could be an interference hazard. Exposure to interfering electromagnetic fields should be minimized.



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